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L29: Entry 11 of 12 File: USPT Aug 21, 2001

DOCUMENT-IDENTIFIER: US 6278981 B1
**** See image for Certificate of Correction ****
TITLE: Computer-implemented method and apparatus for portfolio compression

Brief Summary Text (4):
It is not unusual for large and medium-sized financial institutions, such as banks or insurance companies, to require a risk management engine that allows the computation of daily Value-at-Risk (VaR) estimates of an entire portfolio, which may contain several hundred thousand positions, including substantial volumes of complex derivative products such as swaps, caps and floors, swaptions, mortgage-backed securities, and so on. Moreover, these several hundred thousand positions may have to be evaluated over hundreds or even thousands of different scenarios. To further complicate the task, these financial institutions may require decision support tools for managers and traders that allow performance of inter-day calculations in near-real time.

Brief Summary Text (11):
The present invention is generally directed at providing improved tools for risk management of large and/or complex portfolios of financial instruments. In accordance with particular embodiments of the invention, as described herein, a "compressed portfolio" is generated for a given target portfolio of financial instruments. In general, the compressed portfolio is a relatively smaller and/or simpler portfolio that closely mimics the behavior of the target portfolio, but that requires orders of magnitude less computer memory to store and orders of magnitude less computational time to value. Thus, the compressed portfolio can be used, for example, for risk measurement analyses instead of the target portfolio, thereby providing substantial improvements in computer resource usage with little or no reduction in accuracy.

Detailed Description Text (2):
Embodiments of the present invention are directed to providing advanced portfolio tools for reducing the substantial computational requirements of modem portfolio management. In accordance with such embodiments, a "compressed portfolio" is generated for a target portfolio, and risk measurement calculations are then performed on the compressed portfolio. As used herein, the term "compressed portfolio" contemplates a relatively small and/or simple portfolio that behaves almost identically to an original large and/or complex portfolio, but that requires orders of magnitude less computer memory to store and orders of magnitude less computational time to value. For most purposes, a compressed portfolio need not mimic an original portfolio forever and under every possible state of the world, but rather only during a specified period of interest and over a range that certain specified market factors may take during that period. In addition to computational tractability, compressed portfolios are also powerful tools enabling risk managers to better understand and actively manage their portfolios. By representing portfolio behavior in simpler terms, one can gain insight into the exposures of large portfolios and identify possible remedial actions.

Detailed Description Text (8):
Analytical compression is a practical and powerful methodology for the approximate representation of large cashflow portfolios that exploits their mathematical

properties. The rationale behind analytical compression is relatively straight-forward. To calculate the distribution of portfolio values in the future using a standard simulation, scenarios are usually generated in "risk factor space" (i.e., input) without further information about the subject portfolio. Risk factor space refers to the space of all risk factors including, for example, interest rates, foreign exchange rates, volatilities, index levels, and so on. Thereafter, the portfolio is fully valued under all of those scenarios. Clearly, however, what the analyst is interested in is the portfolio's distribution (i.e., output). Hence, making use of the properties of the portfolio before sampling (i.e., before Monte Carlo generation) results in more efficient calculations. This has an effect similar to applying a variable transformation that captures the portfolio's properties. In addition to the compression of risk factor space, the exploitation of these underlying properties leads to a compact representation of the portfolio. Thus, the extra analytical work yields orders of magnitude increases in computational performance and substantial savings in terms of data storage requirements. In short, the results of analytical compression are (1) a new, compressed representation of a target portfolio by a small number of simple instruments (e.g., bonds) that depend on a new, smaller set of risk factors, and (2) an exact process that describes the behavior of the new underlying risk factors as a function of the original ones. The mathematical underpinnings of analytical compression are described below with reference to particular embodiments of the present invention. Further details can be found in Ron Dembo et al., Analytical Compression of Portfolios and VaR, Algorithmics Technical Paper No. 96-01 (1997), which disclosure is incorporated herein by reference.

Detailed Description Text (18):

By way of further illustration, FIG. 4 contains a flow diagram showing a method for portfolio compression in accordance with another embodiment of the present invention. This method may be implemented, for example, using an apparatus such as that illustrated in FIG. 1, although any other suitable computing apparatus may be used. Referring now to FIG. 4, in accordance with this embodiment a target portfolio of instruments 38 is to be compressed. To this end, instruments 38 are first input to a load instruments routine 40. Instruments 38 may be received, for example, as a collection of data packets defining the composition of the target portfolio. Electronic representations of the financial instruments in the target portfolio can be loaded from an external storage medium (e.g., a data warehouse, a database, a set of comma separated values (.csv) files). In some cases it may be desirable to load the data packets incrementally (e.g., in batches), such as where the size of the target portfolio makes it impractical to load information concerning all of the financial instruments into memory at one time (resulting in significant performance degradation due to disk swapping). In such cases, and with reference to the apparatus of FIG. 1, the size of each incremental load can be set through a parameter passed, for example, to compression engine 20 through a GUI (graphical user interface) or a configuration file, and would typically be based on limitations of memory device 18.

Detailed Description Text (34):

By way of background, and as noted above, the Value-at-Risk (VaR) of a portfolio represents the maximum level of losses that a portfolio could incur over some predetermined time period with a high confidence. More formally, VaR.sub..alpha. (t), the VaR with confidence level .alpha., for a period [0, t], is given by the solution of the equation

Detailed Description Text (35):

where V(R.sub.t, t) denotes the value of the portfolio at time t; R.sub.t represents the vector of underlying (stochastic) risk factors; and .alpha. (one-sided) is typically 0.9 to 0.99. The time interval is usually between 1 and 10 days.

Detailed Description Text (36):

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L47: Entry 5 of 5 File: USPT Mar 31, 1992

DOCUMENT-IDENTIFIER: US 5101353 A
TITLE: Automated system for providing liquidity to securities markets

Brief Summary Text (7):
The existence of problems such as those discussed above has hindered the development of effective automated trading systems and has caused trading volume by users of such systems to remain relatively low. As a result, such systems often remain under-utilized and, in some cases, have had to cease operations altogether. Although a number of patents, such as U.S. Pat. Nos. 3,573,747 to Adams et al., 4,334,270 to Towers, 4,412,287 to Braddock III, 4,554,418 to Toy, 4,556,066 to Towers, 4,674,044 to Kalmus et al., and 4,751,640 to Lucas et al., disclose automated systems useful in trading and valuing securities portfolios, none of these patents recognize or solve all of the problems outlined above. What is needed is an automatic system for trading securities held by institutions which constantly and anonymously provides depth and liquidity to the market by presenting a flow of buy and sell orders in a wide variety of securities in a real time environment without significant changes in the pattern of returns generated by the securities utilized in the original portfolio in a manner that seeks to provide an incremental profit in return.

Detailed Description Text (5):
Within a specified period of a transaction, all executed transactions internal to the system are reported as output through the registered broker/dealer operating the system to a trade data terminal 26 and then to the central reporting facility. Similarly, but only at the end of each trading day, all trades involving each individual security are aggregated, average-priced where appropriate and electronically reported through settlement data terminal 27 for trade settlement to the clearing agent.

Detailed Description Text (28):
That portion of the invention that receives, handles and executes orders for the purchase and sale of securities and reports transactions to the central reporting facility, if appropriate, and to the clearing agent is operated by a registered broker/dealer. That portion of the invention which analyzes price and determines orders is operated by a registered investment adviser. Orders are executed by the system on a price/time priority basis within the system in step 44, although orders could also be executed on a price/size/time priority basis. All orders generated are forwarded to controller CPU 10 which presents them together with those from other clients for display to each client or client process in a manner discribed below. If a purchase order matches a sale order (in whole or in part) created for another client portfolio the controller will match the two and a trade will occur which will be reported to the markets as well as to each client's portfolio trading algorithm. If orders are not executed within the system, control passes to block 46 where controller CPU 10 decides, based on recent trading history, where and how much of each order to place on which external automated market, broker, exchange and/or its own network. Orders placed other than on its own network are submitted on a price/probability of execution basis. Further, if an order has been published to a market, broker or market access network, internally executed transactions

between clients are done on a subject to cancellation basis. As long as an order remains unexecuted, it is subject to cancellation or alteration by the system in step 38 or by the client's process or manually in step 42. In the absence of an external order match control of the program is transferred from block 48 back to block 32 for continuing analysis. The order matching procedure of steps 44, 46 and 48 is discussed in further detail below with regard to FIG. 8.

CLAIMS:

1. An on-line interactive investment processing system for providing added liquidity to markets for investment securities and for managing in a real time environment the interaction of one or more large, institutional portfolios of investment securities with each other and with the securities markets, wherein each portfolio has an inventory including numerous and diverse securities and each portfolio has separate portfolio objectives represented by a specified desired mix of investments in securities and cash reserves through generation of trading decisions in the form of buy and sell orders on behalf of each of those portfolios comprising:

first storage means for collecting and storing securities transaction data and price quotation data both from a plurality of securities markets external to the system and from buy and sell orders and transactions generated internal to the system;

controller means for accessing data stored in said first storage means, for analyzing the data stored in said first storage means and for substantially simultaneously transacting multiple buy and sell orders representing a plurality of securities for one or more of the investor portfolios, wherein said controller means presents orders representing such transactions first only internally to other investors using the system for real time matching and execution and wherein buy and sell orders are executed on a price/time priority basis among internal investors;

second storage means coupled to said controller means for collecting and storing data for each investor portfolio concerning that particular portfolio and for storing buy and sell orders on behalf of that particular portfolio;

investor computer means for maintaining each investor portfolio wherein said investor computer means is coupled to said second storage means for analyzing data concerning the portfolio of that particular investor and for generating buy and sell orders for transmission to said second storage means on behalf of that portfolio in order to retain the portfolio objectives while also providing liquidity ot the securities market;

third storage means coupled to said controller means for collecting and storing data concerning the portfolios of all investors using the system;

supervisory computer means coupled to said third storage means for supervising and ensuring the proper functioning of the system;

external data terminal means coupled to said controller means for linking said controller means to external automated securities brokers and exchanges, for transmitting transaction data to external automated securities brokers and exchanges and for transmitting orders remaining unexecuted after first being presented internally to other investors using the system to external automated securities brokers and exchanges for matching and execution in a substantially real time environment;

trade data terminal means coupled to said controller means for reporting all executed sales internal to the system to a central reporting house; and

settlement data terminal means coupled to said controller means for reporting all trades involving individual securities for settlement purposes to an external organization.

10. A method, performed by a computer system including at least three storage devices maintaining multiple databases, a supervisory computer, a controller, and at least three data terminals, for managing a plurality of internally linked investor portfolios, each having an inventory including numerous and diverse securities traded in securities markets at varying prices which fluctuate upwards and downwards and each having separate portfolio objectives represented by a specified desired mix of investments in securities and cash reserves comprising the computer-performed steps of:

updating data files maintained in a mass storage device connected to a controller central processing unit on a daily basis to reflect corporate actions relating to all managed securities;

updating data files maintained in a mass storage device connected to an investor central processing unit on an ongoing basis with current market information concerning the variance of the price fluctuations of each managed security;

updating data files maintained in a mass storage device connected to an investor central processing unit on an ongoing basis with current market information concerning the normal price of each managed security;

analyzing and altering the desired mix of investments in securities and cash reserves for each investor based on changes in portfolio objectives and according to algorithms customized for each investor as implemented by a central processing unit;

analyzing said variance data, said normal price data and said portfolio objectives according to algorithms developed and maintained within a central processing unit;

generating one or more sets of buy and/or sell orders for securities at specific prices by a controller central processing unit;

offering all buy and sell orders first through internal client investor central processing units to other internally linked investors for real time matching and execution;

electronically executing the buy and sell orders which have been first offered to other internally linked investors;

offering any buy and sell orders remaining unexecuted after having been offered to said other internally linked institutional investors through external central processing units to external automated traders for substantially real time matching and execution; and

electronically executing the buy and sell orders which have been offered to external automated traders.

12. An on-line interactive event-driven investment processing system for providing added liquidity to continuous auction markets for investment securities and for managing in a real-time environment the interaction of one or more large portfolios of investment securities with each other and with the securities markets, wherein each portfolio has an inventory including numerous and diverse securities and each portfolio has separate portfolio objectives represented by a specified desired mix of investments in securities and cash reserves through generation of trading decisions in the form of buy and sell orders on behalf of each of those portfolios comprising:

first mass storage means within a central processing unit for collecting and storing securities transaction data and price quotation data both from a plurality of securities markets external to the system and from buy and sell orders and transactions generated internal to the system;

controller means for accessing data stored in said first storage means, for analyzing the data stored in said first storage means and for substantially simultaneously transacting multiple purchases and sales of a plurality of securities for one or more of the investor portfolios;

second mass storage means coupled to said controller means for collecting and storing data for each investor portfolio concerning that particular portfolio and for storing buy and sell orders on behalf of that particular portfolio;

investor computer means for maintaining each investor portfolio wherein said investor computer means is coupled to said second storage means for analyzing data concerning the portfolio of that particular investor and for generating buy and sell orders for transmission to said second storage means on behalf of that portfolio in order to retain the portfolio objectives while also providing liquidity to the securities market;

third mass storage means coupled to said controller means for collecting and storing data concerning the portfolios of all investors using the system;

supervisory computer means coupled to said third storage means for supervising and ensuring the proper functioning of the system;

external data terminal means coupled to said controller means for linking said controller means to external automated securities brokers and exchanges and for transmitting orders and transaction data to external automated securities brokers and exchanges;

trade data terminal means coupled to said controller means for reporting all executed sales internal to the system to a central reporting house; and

settlement data terminal means coupled to said controller means for reporting all trades involving individual securities for settlement purposes to an external organization.

Given this definition of VaR, consider a portfolio of fixed cashflows, C.sub.i >0 at time t.sub.i, for i=1, . . . , n. The present value of the portfolio today is given by ##EQU1##

Detailed Description Text (38):
The "yield to maturity" of the portfolio, y, is the single rate at which all the coupons can be discounted to give the same portfolio value. Hence, it is given by the unique root of the equation ##EQU2##

Detailed Description Text (44):
As shown above, the yield of the portfolio can be viewed as an alternative representation of the value of the portfolio. Thus, there is a one-to-one mapping between them. The yield further acts with a similar functional form as the rates to give the value of the portfolio.

Detailed Description Text (45):
In view of the foregoing, to obtain the distribution of changes in value of the portfolio, and VaR, using the pricing function V.sub.y (y), one first determines the distribution of the yield. This is not hard task if the joint distribution of the rates is known, since it can be shown that the instantaneous yield changes follow the equation ##EQU4##

Detailed Description Text (54):
The results above can already be used to simplify VaR calculations using simulation by reducing the sample space from n (the dimension of changes in r) to one dimension (changes in y). One can then use V.sub.y (y) to value the portfolio, which still requires the evaluation of a series of n terms. This yield-based Monte Carlo method is a faster and more robust method than simple Monte Carlo because of the reduction in parameter space and the fact that the yield's volatility is much smaller than volatilities of the rate returns. Furthermore, for a portfolio of strictly positive or strictly negative cashflows, VaR can be calculated analytically, without simulation, by noticing that V.sub.y (y) is monotonic and applying the one factor theorem described in Section 2 of Ron Dembo et al., Analytical Compression of portfolios and VaR, Algorithmics Technical Paper No. 96-01 (1997), which discussion is incorporated herein by reference. For more general portfolios, performance can be improved even further by making some approximations, as shown below.

Detailed Description Text (57):
Of course, V(y) is also monotonic, and therefore the VaR approximation could be computed without simulation. The result of this approximation is a series of exponentials with a single exponential function that matches both value and first derivative at one point, and where the term (-y t) "averages" the exponents in the series. In fact, it is shown in Appendix 2 of Ron Dembo et al., Analytical Compression of Portfolios and VaR, Algorithmics Technical Paper No. 96-01 (1997) (which discussion is incorporated herein by reference) that, for portfolios of positive cashflows, V(y) is always dominated by V.sub.y (y), the exact value. That is,

Detailed Description Text (59):
For portfolios with both positive and negative cashflows, the yield, given by the root of Eq. 3 above, is not unique. A simple solution to this problem is to divide the subject portfolio into two subportfolios, one with strictly positive and the other with strictly negative cashflows. The total value of the portfolio can then be expressed as V=V.sup.- +V.sup.+ where ##EQU10##

Detailed Description Text (61):
The yields (y.sup.+, y.sup.-) of both subportfolios are unique in this case, and the total portfolio can be compressed into two cashflows, a positive and a negative one. The two compressed portfolios, respectively, have yields (y.sup.+, y.sup.-),

computed through Eq. 3, coupons (C.sup.+, C.sup.-) and durations (t.sup.+, t.sup.-), computed through Eq. 11 and Eq. 12. Thus, the portfolio value function can be approximated by

Detailed Description Text (64):
Consider now the case of a cashflow portfolio denominated in a different currency, thus having foreign exchange (FX) risk in addition to the interest rate (IR) risk. The value of the portfolio in the domestic currency can be expressed as ##EQU12##

Detailed Description Text (73):
Considering now a general multi-currency, multi-curve case, this can be solved by an iterated application of the above-described single currency case. Consider the general case of a global portfolio consisting of m subportfolios denominated in different currencies (the first of which is the domestic currency), where the portfolio contains IR risk factors. The value of the whole portfolio in the domestic currency can then be expressed as ##EQU16##

Detailed Description Text (81):
The foregoing bucketing methods bucket each cashflow separately to the nearest nodes, without regard for the portfolio to which they belong. Hence, some global portfolio properties, such as its yield to maturity and duration, will not be preserved, because such properties are not additive. Preserving these properties for each individual cashflow does not guarantee that the property at the portfolio is preserved. By contrast, so-called "yield bucketing" maps all portfolio cashflows by preserving these global portfolio properties. In this way, cashflows are bucketed to standard nodes, accounting for all other cashflows in the portfolio, by assuring that the new bucketed portfolio preserves the same value, yield, and duration of the original portfolio. This is a desirable feature where the bucketing technique is to be used in conjunction with analytical compression, since the yield becomes the single risk factor that the portfolio depends on.

Detailed Description Text (84):
Acting on the set of replicating instruments, the target portfolio and the set of scenarios, a simulation module determines the values of every instrument in the target portfolio under every scenario at the specified time points. The results of the simulation module are then input to an optimization problem module, which formulates a linear programming problem to find the optimal replicating portfolio. This problem is then solved using standard linear programming techniques and associated software (e.g., the CPLEX.TM. application distributed by ILOG of Incline Village, Nev.). The solution to the problem is a set of positions to take in the replicating instruments that best matches the behavior of the target portfolio over the specified scenarios. Finally, a construct compressed portfolio module constructs the compressed replicating portfolio from the output of optimization problem module. For example, the construct compressed portfolio module may generate a report identifying actual market transactions to carry out in order to construct the replicating portfolio. The set of instruments contained in the replicating portfolio (i.e., the replicating instruments) might include many different types of instruments, including instruments with optionality (e.g., bond options, caps/floors), in order to provide a more robust replicating portfolio for non-linear instruments.

Detailed Description Text (89):
E(.tau.)=.tau..sup.T.sub.p will denote the expectation of .tau. over the probability distribution p. Finally, E(D.sub.a)=D.sup.T.sub.a p denotes an N-dimensional column vector of expected values of attribute a of the instruments in the compressed portfolio at the end of the replication period.

Detailed Description Text (90):
Given the foregoing, a tracking function may be used to measure the degree to which a compressed portfolio matches a corresponding target portfolio under the possible

values that the attributes might assume during the replication period. The tracking function may be expressed as ##EQU18##

Detailed Description Text (93):
In order to guarantee that the target and compressed portfolios are as close as possible over the entire chosen period, it is natural to require that the values of relevant attributes for both portfolios are the same under current conditions. This leads to the following set of boundary conditions: q.sub.a.sup.T x=c.sub.a ; a=1, . . . , A.

Detailed Description Text (95):
subject to q.sub.a.sup.T x=c.sub.a =1, . . . , A. That is, the equation is to minimize the tracking function over all possible amounts of each instrument in the compressed portfolio, while at the same time ensuring that the total value of such instruments is equal to the value of the target portfolio.

Detailed Description Text (97):
For compression techniques such as analytical compression, the risk factor space will typically include some new variables (e.g., the compressed yields). To simulate the value of the global portfolios under changing market conditions, with both compressed portfolios and portfolios that are not compressed, scenarios must be generated from the joint distribution of the market factors and the new risk factors. These joint distributions are readily available from the yield sensitivities which describe the stochastic processes they follow (see the discussion of analytical compression above). If a scenario set in the original risk factors exists, each scenario is augmented to include the new risk factors (using, for example, Eq. 8, 9 and 16 above).

Detailed Description Text (98):
The following examples are presented to further illustrate features and advantages provided by embodiments of the present invention. The first example involves application of a compression engine, such as that shown in FIG. 2, to a simple portfolio, and demonstrates both the accuracy and possible time savings that may be realized. Consider a small portfolio of long and short positions in 38 US government bonds with maturities ranging from 46 days to 12 years. The current time that was used for valuation purposes was Jul. 22, 1995. This portfolio, which has a theoretical value of $9,482,415.3044 USD, was valued using an upward sloping discount curve whose values at the various term points were approximately 5%. The portfolio was compressed using delta bucketing and analytical compression, after which a VaR number for both the compressed portfolio and the target portfolio were calculated using a Monte Carlo simulation.

Detailed Description Text (112):
In both cases, as illustrated in Table 1 and Table 2, the Value-at-Risk obtained from the compressed portfolio differs from the Value-at-Risk obtained from the original portfolio by at most 1.22%, and is generally much closer. However, the time required to compress the portfolio and calculate the scenario-based VaR from the compressed portfolio varied from approximately 3% to 10% of the time required to calculate the scenario-based VaR from the target portfolio.

Detailed Description Text (131):
The foregoing is a detailed description of particular embodiments of the present invention. Persons skilled in the art will recognize, however, that many alternatives, modifications and/or variations of the disclosed embodiments are possible. For example, analytical compression and scenario-based compression are only two of a myriad of techniques that can be used to express portfolios in simpler form. Other techniques have already shown excellent practical results, including so-called Arrow-Debreu Compression, in which results of previous simulations are used to construct a new representation of a portfolio in a piecewise sense (using the analog of delta functions). Also available are so-called

Power Series Methods, in which the portfolio value function is approximated by a local series expansion around the current mark-to-market price. These methods, in combination with harmonic analysis, provide an elegant and fast computational technique, as discussed in C. Albanese and L. Seco, Harmonic Analysis in Value at Risk Calculations, Working Paper, RiskLab-University of Toronto (1996) (accepted for publication in Finance and Stochastics). The present invention embraces all such alternatives, modifications and variations that fall within the letter and spirit of the claims, as well as all equivalents of the claimed subject matter.

CLAIMS:

1. A computer-implemented method for compressing a portfolio of financial instruments for purposes of portfolio management, the method comprising the steps of:

selecting one or more financial instruments to be compressed from among a plurality of financial instruments in an original portfolio;

generating a compressed subportfolio from the selected financial instruments, wherein said generating includes replacing a subset of the selected financial instruments with a synthetic financial instrument capable of replicating an aggregate behavior of the replaced subset;

combining the compressed subportfolio and any non-compressed financial instruments from the original portfolio into a compressed portfolio;

calculating a measure of risk for the compressed portfolio; and

performing risk management of the original portfolio based on the calculated measure of risk for the compressed portfolio.

17. A computer-readable storage medium embodied in a computer and containing a set of instructions for causing a computer to compress a portfolio of financial instruments, said set of instructions including instructions for:

selecting one or more financial instruments to be compressed from among a plurality of financial instruments in an original portfolio;

generating a compressed subportfolio from the selected financial instruments, wherein said generating includes replacing a subset of the selected financial instruments with a synthetic financial instrument capable of replicating an aggregate behavior of the replaced subset;

combining the compressed subportfolio and any non-compressed financial instruments from the original portfolio into a compressed portfolio;

calculating a measure of risk for the compressed portfolio; and

performing risk management of the original portfolio based on the calculated measure of risk for the compressed portfolio.

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L7: Entry 1 of 1 File: USPT Aug 21, 2001

DOCUMENT-IDENTIFIER: US 6278981 B1

**** See image for Certificate of Correction ****

TITLE: Computer-implemented method and apparatus for portfolio compression

Detailed Description Text (3):

Embodiments of the present invention may be implemented, for example, using a so-called "compression engine." Given a target portfolio of financial instruments, a compression engine provides a means for creating a compressed portfolio consisting of simpler and/or fewer instruments that will replicate the behavior of the target portfolio over a range of possible market outcomes for a pre-defined period in the future. The computational effort to perform a risk analysis of the compressed portfolio is substantially less than that of the target portfolio. Furthermore, given its simplicity, the compressed portfolio provides a better understanding of the market risks facing the holder.

Detailed Description Text (34):

By way of background, and as noted above, the Value-at-Risk (VaR) of a portfolio represents the maximum level of losses that a portfolio could incur over some predetermined time period with a high confidence. More formally, VaR.sub..alpha. (t), the VaR with confidence level .alpha., for a period [0, t], is given by the solution of the equation

Detailed Description Text (86):

A second assumption underlying the scenario-based compression model is that only a finite number N of financial instruments are available for creating the compressed portfolio. Because the compressed portfolio will only be used as a surrogate for valuing the target portfolio and its attributes, it may be made up of any instruments whose prices are known. Moreover, the liquidity of the instruments is not relevant unless the compressed portfolio is to be used for purposes other than valuation (for example, hedging).

Detailed Description Text (125):

Another significant advantage of portfolio compression in accordance with embodiments of the present invention is the lack of liquidity restrictions on the replicating variables (i.e., the positions of instruments in the compressed portfolio). In practice, however, some liquidity restrictions make the solution of the compressed portfolio more stable. This benefit also derives from the fact that the essence of a compressed portfolio, as just discussed, is that it price correctly. Since the compressed portfolio need not be comprised of tradeable instruments, it may contain fictitious instruments in any quantity provided the price of such instruments is "fair" with respect to the market. Such fictitious instruments can be priced using analytical models based on, for example, no-arbitrate conditions or equilibrium principles, as described in John C. Hull, Options, Futures and Other Derivatives (3E) 572 (Prentice-Hall 1997).

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Another significant advantage of portfolio compression in accordance with embodiments of the present invention is the lack of liquidity restrictions on the replicating variables (i.e., the positions of instruments in the compressed portfolio). In practice, however, some liquidity restrictions make the solution of the compressed portfolio more stable. This benefit also derives from the fact that the essence of a compressed portfolio, as just discussed, is that it price correctly. Since the compressed portfolio need not be comprised of tradeable instruments, it may contain fictitious instruments in any quantity provided the price of such instruments is "fair" with respect to the market. Such fictitious instruments can be priced using analytical models based on, for example, no-arbitrate conditions or equilibrium principles, as described in John C. Hull, Options, Futures and Other Derivatives (3E) 572 (Prentice-Hall 1997).